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MOBILE HIGH-CONTAINMENT  
ISOLATION: A UNIQUE PATIENT CARE  
MODALITY

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## BRIEF REPORTS

# Mobile high-containment isolation: A unique patient care modality

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During the past 15 years, several infectious viral hemorrhagic diseases, including Marburg disease, Lassa fever, and Ebola fever, have been identified. These, and other exotic diseases, are defined as "highly virulent transmissible conditions caused by dangerous pathogens for which patients require specialized handling and care."<sup>1</sup>

The three specific diseases cited have several similarities. First, fatality rates are impressive: 10% for Lassa fever, 25% for Marburg virus, and 50% to 90% for Ebola fever (CJ Peters, U.S. Army Medical Research Institute of Infectious Diseases [USAMRIID], Fort Detrick, Md., personal communication, June 1983). Second, differential diagnosis is complicated by the non-specificity of early signs and symptoms such as fever, headache, and myalgias. Third, no vaccines are available, and treatment is primarily symptomatic and supportive. Last, these diseases are highly communicable and are transmitted through excretions, secretions, and blood, thus endangering exposed medical, nursing, and laboratory personnel. Transmission by air appears questionable, although it has been implicated in one episode of Lassa fever, and the potential for airborne transmission has been demonstrated in the laboratory.<sup>2</sup>

Although the aforementioned diseases occur naturally in Africa, in this era of rapid international air travel importation is not unlikely.<sup>3</sup>

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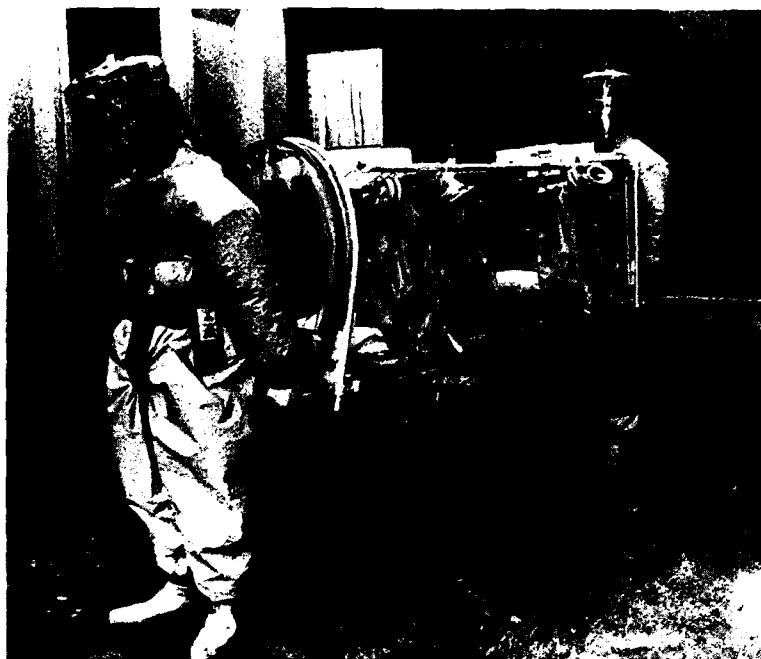
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The tourist industry, events drawing international attendance, U.S. troops stationed throughout the world, and government activities such as the Peace Corps enhance the possibility of importation. In point of fact, there have been documented cases of Lassa fever imported to the United States, United Kingdom, and Germany.<sup>4</sup>

Because of the lethality and communicability of these diseases, it is recommended that the patient and any laboratory specimens be handled under high-containment isolation conditions (protective level 4 [P-4]) as soon as possible.<sup>1,2</sup> High-containment isolation provides a means whereby a patient, laboratory specimens, or both can be physically separated by a microbiologic barrier, yet safely handled by attending personnel. High-containment isolation incorporates three basic principles: protective barrier, negative pressure, and filtered air.

Unfortunately, few medical centers in the world possess the sophisticated P-4 patient care and laboratory facilities necessary for appropriate management of the patient and investigation of the disease. The only centers in the United States that can provide this type of containment are the Centers for Disease Control in Atlanta and USAMRIID, Fort Detrick, Maryland. This demonstrates the necessity for a safe method of transporting a patient from anywhere in the world to one of these two centers. In response to this need, USAMRIID has established an evacuation system using a trained team and mobile P-4 units for persons suspected or known to have contracted one of the exotic diseases.

The Trexler Patient Isolator System, developed by C. P. Trexler and manufactured by Vickers, Ltd., Basingstoke, England, consists of three units: the Stretcher Isolator (SI), the Aircraft Transit Isolator (ATI), and the Bed Isolator



**Fig. 1.** Stretcher Isolator.



**Fig. 2.** Aircraft Transit Isolator.

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(BI) (Figs. 1 through 3). Each unit encloses the patient in a negatively pressurized transparent polyvinyl chloride (PVC) chamber. Air is exhausted actively from the unit, creating a partial vacuum, or negative pressure, and allowing

passive air intake. Air entering and exiting the units is filtered through high efficiency particulate air (HEPA) filters that remove a minimum of 99.7% of all particles ranging in size from 0.02 to 2.0  $\mu\text{m}$ .<sup>5</sup> The three units are compatible



**Fig. 3.** Bed Isolator.



**Fig. 4.** Patient care is performed through use of gloved sleeves and half-suits (viewing panel has been removed).

with each other and can be connected by using a PVC sleeve to create a "tunnel" between the units. A patient can then be transferred from one unit to another without compromising the integrity of the system or contaminating the environment. Health care personnel accomplish patient care activities through gloved sleeves in the "walls" of the isolators. The ATI and BI also have half-suits that allow staff

members to work and interact closely with the patient. Food, fluids, and supplies may be passed into the unit and laboratory specimens removed via supply ports without breaking containment (Fig. 4).

The health care team that operates this system, known as the Aeromedical Isolation Team, is composed of U.S. Army physicians, nurses, and medics. These individuals are trained in the



**Fig. 5.** Team member wearing protective garb and backpack respirator.

treatment of patients with infectious diseases, principles and practices of infection control, and operation of these high-containment units. When needed, the Aeromedical Isolation Team, equipped with the SI and ATI, is promptly deployed to any part of the world by the U.S. Air Force.

Once deployed, team members take the SI and other equipment to the patient's location. Before entering a contaminated area, the four individuals don protective garb (Fig. 5). Clean air is provided by battery-operated backpack respirators with HEPA filtration, which moves 12 L/min to provide a positive-pressure protective garment. PVC jumpsuits, clear vinyl hoods, booties, and gloves provide the barrier between the team members and the infectious patient and potentially contaminated environment. After dressing in the protective garb, the team members take the SI to the patient's bedside. The team physician and nurse perform a baseline evaluation and an initial assessment. The



**Fig. 6.** Aircraft Transit Isolator showing port for connection of PVC tunnel.

battery-operated air supply of the SI is turned on and the patient is assisted into the unit. A clear vinyl viewing panel is secured over the open port, thus initiating containment at the P-4 level.

The team transports the unit to an intermediate area where the outside of the isolator and the protective garb of attending personnel are decontaminated. This procedure will not be described in detail, but essentially, all contaminated surfaces are sprayed with a 1:10 dilution of 10% sodium hypochlorite. The Centers for Disease Control recommend use of 0.5% sodium hypochlorite (household bleach) in 10% aqueous solution.<sup>6</sup> Because of limited data concerning the efficacy of disinfectants on high-hazard exotic diseases, a 1.0% solution of sodium hypochlorite is used in all field situations.

Once the decontamination process is completed, team members take the contained patient to the waiting aircraft where the ATI is on board. This somewhat larger unit operates on

a 28 V aircraft power during flight and 12 V battery power at other times.

The SI is positioned immediately in front of the ATI and the two units are joined by using a PVC sleeve to create the tunnel (Fig. 6). The patient is transferred from the SI through the PVC tunnel into the ATI. Similarly to cutting an umbilical cord, the sleeve is gathered and tied off at four points and severed in the middle. The SI is moved away from the ATI and secured in another location in the aircraft. A second assessment of the patient is obtained, and continuous observation and monitoring is conducted by team members throughout the flight home. On return to USAMRIID, the patient can be transferred to one of the two BI units or the high-containment patient care suite. All specimens are taken to the appropriate P-4 laboratories for analysis. The patient remains in P-4 isolation attended by USAMRIID professionals until diagnosis of an exotic disease is ruled out or past the period of communicability, usually 28 days.

The risk of importation of an exotic disease and the need for a high-containment isolator system has been recognized and implemented by the United Kingdom, United States, Canada, and Australia.<sup>7</sup> The USAMRIID Isolation Team, however, offers additional protection against importation. That is, the team travels to the patient and initiates high-containment isolation on-site rather than waiting for the patient's arrival at one of the high-containment facilities. The USAMRIID Aeromedical Isolation Team and the mobile isolation units add another dimension to this unique patient care modality.

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## APPENDIX

### High-containment isolators

**The Stretcher Isolator (Fig. 1).** The SI is the smallest unit in the three-part system. Its design consists of an upper framework supporting a flexible transparent envelope mounted to a stretcher base. It weighs approximately 85 pounds. The blower motor operates on a 6 V battery. The walls of the envelope have four gloved sleeves on each side to allow access to the patient. A supply port on top permits passing in needed articles. Patient care capabilities include intravenous (IV) therapy, oxygen, and portable cardiac monitoring. The unit, designed to be hand-carried, can also be transported via ground vehicle or helicopter.

**The Aircraft Transport Isolator (Fig. 2).** The ATI unit is somewhat larger, is more comfortable for the patient, and has greater patient care capabilities. The ATI design consists of a lower framework housing the blower motor and support systems and an upper frame from which the PVC envelope is suspended. The unit weighs approximately 400 pounds and has wheels at the base. It has gloved sleeves and a half-suit on each side permitting even greater access to the patient. The ATI is equipped with two IV arms, oxygen, suction, and portable cardiac monitoring equipment. The unit operates on 12 V batteries or DC aircraft power. A supply port is located at the foot of the unit where food, fluids, and medications can be passed in to the patient. Two long closed cylinders built into the wall of the isolator are used for trash and waste. The unit can be transported by ground vehicle or aircraft.

**Bed Isolator (Fig. 3).** The BI consists of two parts. The larger is the patient section. A negatively pressurized PVC envelope, large enough to fit over a standard hospital bed, is suspended from an upper frame. There is a narrow patient walkway on one side of the bed. A portable commode is located in the corner. Patient care capabilities include IV therapy, oxygen, suction, ECG, and x-ray. Connected by a PVC sleeve is the supply section of the isolator. This smaller PVC envelope is equipped with shelves providing storage space for supplies and a work area for personnel. The supply section is also under negative pressure, and access is by way of gloved sleeves. This remains attached to the patient section for the duration of patient occupancy. If required, the BI can be dismantled, packed, transported, and reassembled as necessary.